Salinas Dam
Salinas River, 1½ miles Northeast of Pozo Road,
3½ miles East of the intersection with State Route 58
Santa Margarita Vicinity
San Luis Obispo County
California

HAER No. CA-183

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PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
National Park Service
Department of the Interior
San Francisco, California

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HISTORIC AMERICAN ENGINEERING RECORD

SALINAS DAM

HAER No. CA-183

Location: Salinas River in San Luis Obispo County, California, about 1 ½ miles northeast of Pozo Road, about 3 ½ miles east of the intersection with State Route 58
U.S.G.S. 7.5' Quadrangle: Lopez Lake
UTM Coordinates: 10 / E 727260 / N 3913120

Date of Construction: 1941-1942

Architect/Engineer: Raymond A. Hill of Leeds, Hill, Barnard, and Jewett
Builder: L.E. Dixon Company

Present Owner: Army Corps of Engineers, Los Angeles District

Present Use: Municipal Water Supply Storage

Significance: The Salinas Dam, a "hoof" type, inclined, variable radius arch dam, was designed by Raymond A. Hill, an important structural engineer who worked in Los Angeles, California between 1919 and the 1960s. It retains a high degree of integrity to its appearance at the time of its construction in 1941-42. The dam is significant for its direct association with military preparedness in San Luis Obispo County just before and during the early years of World War II, and as a distinguished example of heroic engineering and construction under wartime conditions. The dam stands as a monument to the "can do" attitude of the Army and its contractors during this period, the attitude that, because great challenges were facing the nation, essentially any obstacle could be overcome given sufficient will and resources. Whether considered within the context of military construction or dam construction in California, the Salinas Dam appears to be a significant property.

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I. DESCRIPTION

The Salinas Dam is a reinforced concrete arch structure set on a concrete footing with concrete buttresses and struts at its abutments. **Photographs CA-183-1 and Photograph CA-183-2** offer a general view of the downstream face of the dam. The dam creates a narrow reservoir, called Salinas Reservoir (a.k.a. Santa Margarita Lake), that is about five miles long and rarely more than a quarter mile wide. The dam is situated in a narrow canyon near the headwaters of the Salinas River, just above the Santa Margarita Valley, upstream from the town of Santa Margarita. The location of the dam is shown in Figure 1.

As discussed under "Historical Overview," the dam was built for the Quartermaster Corps, U.S. Army, to supply water to Camp San Luis Obispo, an Army base that was built in 1941-42, and secondarily for the City of San Luis Obispo. Before work was completed, however, jurisdiction for the dam and Camp San Luis Obispo was transferred from the Quartermaster Corps to the Army Corps of Engineers. The engineering elements of Salinas Dam were described succinctly in a completion report prepared in 1942 by D.P. Lane. Lane, the Area Engineer for the Corps of Engineers, was in charge of managing the dam after it was transferred to the Corps in early 1942. He wrote:

> Salinas Dam is an inclined, variable radius arch of the "hoof" type. The arch, instead of being cast into the foundation rock, rests upon a concrete footing which extends up the canyon walls to about two-thirds of the height of the dam. Above this point the arch thrust is carried by concrete buttresses. The maximum height of the dam is 185 feet. The top element of the arch is about 455 feet in length. The maximum thickness is 13.61 feet at the bottom. The upstream radius at the top is 180 feet, reducing to 70 feet at the bottom.
>
> Adjacent to the right buttress and at a right angle with it is a 100-foot long spillway crest controlled by a 100-foot by 18-foot drum gate. The spillway discharge channel is curved in plan and super-elevated. The discharge capacity of the spillway up to the elevation of the overflow crest of the arch (elevation 1320) is about 27,000 second feet. The combined maximum discharge of spillway and arch overflow to elevation 1325 is about 50,000 second-feet.[1]

[1] D.P. Lane, Major, Corps of Engineers, "Completion Report, Salinas River Project Near Santa Margarita, California, Sub-Post of Camp San Luis Obispo, California." Fixed Fee Contract Job No. T-41-5," May 9, 1942. National Archives, RG 77, Construction Completion Reports, 1917-1943, Salinas River Project, Box 274.

Lane's description accurately describes the situation today, except that the drum gate was never installed. **Photograph CA-183-3** shows the top of the spillway and concrete fill in the area where the drum gate was intended to be placed.

The dam is a concrete arch of the "variable-radius" design, i.e., not a constant radius in the manner of many arch dam structures. The dam spans a narrow canyon and is V-shaped, conforming to the general contours of the canyon. The essential form of the dam may be seen in **Photographs CA-183-22** and **Photograph CA-183-23**, which are photographic copies of the plans for the dam.

The arch of the dam is 185' in length at the bottom and more than 300' at the top. The arch is 135' tall at the center. The arch of the dam is carried on thick concrete footings. Large concrete buttresses are located on the downstream face of the dam, extending several hundred feet perpendicular to the face of the dam. The buttresses are solid concrete elements, which carry the thrust of the edge of the dam. The left (east) buttress is shown in **Photograph CA-183-4**; the right (west) buttress in **Photograph CA-183-5**. The spillway for the dam exists at the right of the dam and is tied structurally to the right (west) buttress **(Photograph CA-183-6)**. It is a passive spillway, with no gates. The spillway chute is spiral in shape **(Photograph CA-183-7)**. In the late 1960s or early 1970s the rock face below the spillway chute was treated with gunite to prevent erosion **(Photograph CA-183-8)**.

The top of the dam is accessed by an interior stairway in the right (west) buttress and an exterior stairway and ladder on the left (east) buttress. The entrance to the interior stairway is located midway up the right (west) buttress and accessed by way of a metal catwalk that extends across the downstream face of the dam and a concrete stairway that extends diagonally up the face of the dam and buttress. **Photograph CA-183-9** shows the catwalk and **Photograph CA-183-10** shows the diagonal stairway and doorway. A similar diagonal stairway that extends up the east side of the dam has been closed because it was unsafe **(Photograph CA-183-11)**. Inside the right (west) buttress a concrete stairway leads to a landing built to house the machinery and counterweight for the drum gate which was never installed **(Photograph CA-183-12)**. A metal spiral staircase extends through the buttress to the top of the dam. At the base of the left (east) buttress is a mass of poured concrete formed in irregular stepped layers resembling an amphitheater **(Photograph CA-183-13)**. This concrete mass, poured to stabilize the rock face, also serves as a stairway up the left (east) side of the dam and leads to a rung ladder imbedded in the dam face **(Photograph CA-183-14)**. Another stairway extends from the left (east) buttress diagonally down the dams upstream face.

Three large concrete struts are located in the river bed below the right buttress and slightly upstream from the spillway. These struts were poured to align with the thrust of the right buttresses and designed to support the buttresses as well as the sandstone ledges upon which they sit. Two of the struts are shown in **Photograph CA-183-15**, the third can be seen in the river bed at the base of the spillway in **Photograph CA-183-8.** Plans for the struts are reproduced as **Photograph CA-183-27.**

The dam was designed with three crest heights: 1301', 1325', and 1320'. Elevation 1325' is the top of the dam, adjacent to the buttresses. Elevation 1320' is the height of most of the center of the arch; the dam was designed to be overtopped under extreme conditions, with this lower (1320) level serving as an emergency spillway **(Photograph CA-183-16)**. Elevation 1301' is the height of the spillway and the effective height of the reservoir.

The dam includes five 24-inch pipes with intakes on the upstream face of the dam, three on the east end and two on the west. The intake pipes on the right buttress are used to spill water into the Salinas River **(Photograph CA-183-17 and Photograph CA-183-18)**. The intake pipes through the left buttress provide drinking water to San Luis Obispo and are located on platforms situated at the dams 1280', 1260', and 1220' elevations. Flexible tubing was added to the ends of these intakes to allow water to be drawn from varying levels to maintain outflow water quality. The flexible tubes are controlled by a set of booms and winches seen at the center of **Photograph CA-183-19. Photograph CA-183-18** also shows the concrete structure that houses the stilling well, an instrument that accurately measures the water level of the lake (see also **Photograph CA-183-20**). The three intake pipes on the left buttress carry water through the dam into a common manifold located near the east end of the catwalk located near the base of the downstream face of the dam. From there a single 24" pipe carries the water to the pumphouse located near the base of the dam.

The concrete pumphouse, shown in **Photograph CA-183-A-1**, is located on the east bank of the Salinas River near the base of the dam. The location of the pumphouse in relation to the dam can be seen in **Photograph CA-183-2**. Water flows by gravity into the 24" pipe and then into the pumphouse at the northeast corner. From there it continues to flow by gravity through the pumphouse uninterrupted except in times of very low water. When the level of the reservoir gets too low to provide adequate pressure to force the water through the system, the flow is diverted through several small pumps which push the water through the system. The pumphouse is rarely used, perhaps only once in the last ten years.[2] The interior of the pumphouse and the pumping equipment are shown in **Photograph CA-183-A-2.**

II. HISTORICAL OVERVIEW

Construction History

The Salinas Dam was built in 1941-42 by a private construction firm, according to plans and specifications that were developed by a private architect and engineer (A&E) contractor and approved, first by the Army Quartermaster Corps and later by the Army Corps of Engineers. The principal intended purpose of the dam was to store drinking water for use by Army troops stationed at Camp San Luis Obispo, an infantry training base that was under construction at the same time as

[2] Telephone interview with Kenneth (Rick) Meeks, August 21, 1996. Meeks is the Water Systems Superintendent for the San Luis Obispo County Engineering Department.

the dam. Secondarily, the water was also intended to serve the anticipated increases in water demand for the City of San Luis Obispo.

Camp San Luis Obispo, like many military installations in California that are considered World War II-era bases, was planned and largely constructed just prior to American participation in World War II. Although not formally at war, the American military engaged in a period of frenetic mobilization in the years just before the Japanese attack on American forces at Pearl Harbor. In May 1940, as German forces were on the attack in France, Congress authorized an increase in American armed forces from about 200,000 to one and one-half million. Camp San Luis Obispo and dozens of other military posts throughout the United States had their origin in this massive pre-war mobilization.

Camp San Luis Obispo, which is located about four miles northwest of downtown San Luis Obispo, was first activated in 1928 by the State of California as a National Guard training facility. Although it was the largest training facility for the Guard in California, this 5800-acre facility was used less than full time and had few permanent residents between 1928 and 1940. In 1940, this minor state-owned facility was taken over by the Federal government and activated as a regular Army camp, commissioned as an infantry division training center. With virtually no permanent residents prior to 1940, the camp was planned to be occupied by more than 20,000 soldiers in the summer of 1942, which would make it one of the most densely-occupied training facilities on the West Coast and nearly as large as the nearby City of San Luis Obispo.[3] At that time, the eamp was expanded to more than 14,000 acres by the Army through a lease arrangement with the U. S. Forest Service, manager of much of the adjacent lands.

While it was under the jurisdiction of the State of California, the camp's water needs had been met by a small reservoir on the base, which were connected to the water system of the City of San Luis Obispo. The City's system relied upon reservoirs west of the San Lucia Mountains that stored the waters of relatively small coastal streams. The volume of water in these streams was entirely inadequate, however, to serve the anticipated massive influx of military personnel. In its preliminary plans for Camp San Luis Obispo, the Army Quartermaster Corps contemplated constructing a

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[3] The history of Camp San Luis Obispo as a California National Guard facility is recorded in detail in the Biennial (later Quadrennial) Reports of the Adjutant General (now the Military Department), State of California, 1928 to present. Additional information about the camp is found in miscellaneous material in the library at the Citizen Soldier Museum, Sacramento. This history of Camp San Luis Obispo as a Federal facility is recorded in various sources. A succinct and accurate history is provided in Headquarters, Camp San Luis Obispo, "Camp San Luis Obispo: Home of the National Guard," n.d. See also Daniel E. Kreiger, *San Luis Obispo County: Looking Backward into the Middle Kingdom* (Windsor Publications, 1988) and Harth, et. al., *War Comes to the Middle Kingdom*; and Robert H. Born, "Salinas Dam -- A Remarkable Engineering Achievement," a paper in support of nomination of Salinas Dam as a significant Los Angeles Section and National Civil Engineering Landmark Project, American Society of Civil Engineers, November 10, 1993. There is some disagreement as to the population of Camp San Luis Obispo during World War II, ranging from 10,000 to 20,000. Kreiger estimates that 500,000 infantry soldiers were trained there during the course of the war.

supplementary system which would store the water of Chorro Creek, a small stream which flows through the camp, supplemented by wells in and around Chorro Valley. Early analyses of this proposed system revealed, however, that the supply would be insufficient to serve the intended personnel at the expanded base.

The manner in which the Salinas Dam was designed is in some respects typical of cantonment construction before and during American involvement in World War II. A significant difference, as discussed below, was that the pace of design and construction work was particularly hurried and complicated, owing to the scope of the work required for a dam compared to the much simpler structural engineering work associated with cantonment design.

Before the 1940 mobilization effort, the Quartermaster Corps maintained close control over the design and construction of Army cantonments, as well as Air Corps bases. While it would contract out for some specialized design work, the Quartermaster Corps retained the in-house expertise needed to accomplish most such work. The Quartermaster Corps also monitored most construction contracts for the work it designed. During World War I, however, the Army elected to contract with private firms to accomplish most of its design work and assigned to the Corps of Engineers the responsibility for monitoring both design and construction activities.[4]

Between 1940 and early 1942, the Quartermaster Corps retained general control over cantonment construction but was forced to contract with private A&E firms for most of the design work, owing to the massive scale of the work that was required. These private A&E firms laid out the bases, designed the roads, sewers, and other infrastructure. They also designed buildings, although they relied upon standard plans wherever it was possible and feasible. These standard plans had been developed, for the most part, by the Corps of Engineers rather than the Quartermaster Corps.[5]

Like most military construction between 1939 and 1945, Camp San Luis Obispo was designed by an A&E contractor and built by a private construction firm. The A&E firm was Leeds, Hill, Barnard, and Jewett, a Los Angeles-based structural engineering firm. The contractor was L.E. Dixon Company, also of Los Angeles. Both were awarded contracts by the Quartermaster Corps in 1940 to design and build the camp itself -- the barracks, administrative buildings, roads, sewers, and appurtenant facilities needed for the major new Army training camp. Design work for Camp

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[4] Erna Risch, *United States Army in World War II: The Quartermaster Corps: Organization, Supply, and Services,* Vol. I (Washington, D.C.: Center of Military History, United States Army, 1995), 16-17.

[5] John Garner, *World War II Temporary Buildings: A Brief History of the Architecture and planning of Cantonments and Training Stations in the Untied States* (USACERL Technical Report CRC-93/01, 1993.) This volume represents the most comprehensive treatment available regarding the design and construction of stateside military bases during World War II. It deals with the programs of the Navy Bureau of Yards and Docks as well as the Army Corps of Engineers.

San Luis Obispo was initiated in the winter of 1940 and construction began shortly thereafter. The original cost-plus-fixed-fee (CPFF) contracts to the A&E and construction companies did not specify dam design or construction because the need for a dam had not been recognized.

The design history of the Salinas Dam is complicated by the fact that design began under the supervision of the Quartermaster Corps of the U.S. Army but was completed under control of the Army Corps of Engineers. On January 1, 1942, the Corps of Engineers took over responsibility for completing Camp San Luis Obispo and many other Army bases then under construction.[6] The change in jurisdiction was advantageous with respect to the dam because the Corps of Engineers, in addition to its extensive military construction responsibilities, was, along with the Bureau of Reclamation, the Federal agency with the greatest expertise in dam design and construction. The change was fortuitous with respect to the consulting engineers as well in that the lead partners in the design firm were ex-officers with the Corps of Engineers and were familiar with the water development design standards used by the agency.

The idea for constructing the Salinas Dam is generally credited to Raymond A. Hill of the firm, Leeds, Hill, Barnard and Jewett.[7] Leeds, Hill, Barnard, and Jewett was a distinguished civil engineering firm from Los Angeles, with extensive experience in dam design. Originally hired by the Quartermaster Corps to design the cantonment at Camp San Luis Obispo, the firm was also called upon to design the dam, a logical decision by the Quartemaster Corps given the existence of an open CPFF contract and the fact that the firm had on its staff one of the most experienced dam designers then working in California.

Leeds, Hill, Barnard, and Jewett was created in 1930 with the blending of two much older civil engineering consulting firms: Leeds and Barnard and Quinton, Code, and Hill. Leeds and Barnard was formed in 1913 with the partnerships of Charles T. Leeds and William Keeper Barnard.[8] Quinton, Code, and Hill was formed in 1914. One of the founding partners was Louis Hill, Raymond A. Hill's father. Louis Hill was an accomplished dam designer himself, having worked for the Bureau of Reclamation (Reclamation Service) between 1903 and 1914, during which time

[6] Risch, *United States Army in World War II*, 16-17. The Quartermaster Corps retained its pre-war supply function but would never again be involved in construction.

[7] Born, "Salinas Dam -- A Remarkable Engineering Achievement," 1993, 2. Mr. Born based his history of this large facility upon inspection of original reports and personal interviews with Mr. Hill in 1956. The history of the early design work is chronicled in much greater detail in Leeds, Hill, Barnard, and Jewett, "Report to United States Engineer Office, Los Angeles, California on Analysis of Design of Salinas River Project," April 1, 1942. This report is the most important source on the history of this project. It was used extensively by Born and for this document as well.

[8] "Memoir of William Keefer Barnard," *Transactions of the ASCE*, Vol. 106 (1941), 1543-4; "Memoir of Charles Tileson Leeds," *Transactions of the ASCE*, Vol. 126 (1961), Part V, 4-5.

he designed the well-known Roosevelt Dam as part of the Salt River Project.[9] Louis Hill remained with Quinton, Code, and Hill, and later Leeds, Hill, Barnard and Jewett until his death in 1938.

Raymond A. Hill was born in Colorado, where his father was a professor at the Colorado School of Mines. Like his father, Raymond Hill attended the University of Michigan and, again like his father, worked for the Bureau of Reclamation, or Reclamation Service as it was then called. He served in the Army Corps of Engineers during World War I, attaining the rank of Lieutenant. Shortly after the war, he joined his father's firm in Los Angeles and remained with the firm until retiring in the early 1960s.[10] In a long career of consulting engineering, Hill worked under contract with the Corps of Engineers, Bureau of Reclamation, State of California, the cities of Los Angeles and San Diego, as well as the governments of Australia, Haiti, Greece, Turkey, and Pakistan.

By 1941, only Leeds and Hill remained of the four named partners of the firm, although, as noted, the "Hill" in the name actually referred to Raymond A. Hill's father, Louis. Both Hill and Leeds had strong connections to the military and the Corps of Engineers in particular. As noted, Hill had been an officer in the Army Corps of Engineers during World War I. Leeds' connections were even stronger. He attended West Point and served in the Corps of Engineers in the Philippines and elsewhere before being appointed as the District Engineer for the Los Angeles District of the Corps of Engineers in 1917. He attained the rank of Colonel before leaving the Corps to work full-time with Leeds and Barnard.[11]

Although both had hydraulic engineering experience, it was Hill rather than Leeds who worked on the Salinas Dam.[12] Hill expressed concerns about the water supply at Camp San Luis Obispo in December 1940, before the firm was even officially under contract to design the base. In January 1941, the Quartermaster Corps authorized Hill to explore potential dam sites in the vicinity, capable of yielding 2200 acre-feet annual supply, a supply deemed adequate for the design capacity of 20,000 men at Camp San Luis Obispo.[13]

Following a four-month reconnaissance of surface water supplies in the area, Mr. Hill suggested construction of a dam on the Salinas River, joined by 15 miles of pipeline (including a one-mile tunnel through the Cuesta Grade, called the Cuesta Tunnel), and miscellaneous filtration and delivery

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[9] "Louis A. Hill," *Civil Engineering,* (December, 1938), 851.

[10] "Raymond A. Hill," *Civil Engineering* (October, 1962), 68.

[11] "Memoir of Charles Tileson Leeds." *Transactions of the ASCE*, 126(1961), Part V, 4-5.

[12] Leeds by contrast was in charge of the cantonment construction. He details his work in this regard in a valuable series of articles in *Civil Engineering*, entitled "A West Coast Cantonment." Part 1, (November, 1942), 541-4; Part 2, (November, 1942), 611-2. Perhaps for security reasons, Leeds never specifically names the cantonment but the details of the article clearly indicate that he was describing his work at Camp San Luis Obispo.

[13] Born "Salinas Dam -- A Remarkable Engineering Achievement," 1993, 2.

systems within the boundaries of Camp San Luis Obispo.[14] Although the selected site posed expensive problems of transport, the alternative sites -- both in the Salinas River drainage as well -- would have been even more expensive to construct and were inferior in other regards as well.

Hill's suggested plan was presented to the Quartermaster Corps in a report of April, 1941, less than half a year after the design work was initiated for Camp San Luis Obispo. The heroic aspect of Mr. Hill's proposal -- and ultimately the most significant aspect of the design of the facility -- was the plan to construct a dam in time to provide drinking water to the base before its planned opening in the summer of 1942, a schedule of six months from design to operation. The daunting task, then, was to build a dam during the summer and fall of 1941, complete the project in time to store the winter flows of 1941-42, and impound that water for use by troops during the summer of 1942.[15]

The site Hill had selected was situated at the head of the Santa Margarita Valley, northeast of San Luis Obispo, at the headwaters of the Salinas River between the towns of Santa Margarita and Pozo. The remote site posed difficulties in that it was 15 miles distant, and a mountain range separated it from Camp San Luis Obispo. Hill insisted, however, that the dam site was feasible and that "if construction were promptly initiated" the project would be on-line before the first troops arrived, in about 14 months from the submission of the initial report.

Hill's April 1941 plan was an outline of the basic elements of the project, including the crest elevations that he felt would need to be attained to store sufficient water. It was not, however, a fully developed plan; as discussed below, the designs and specifications for the project were under constant revision throughout construction. Recognizing the nearly impossible construction schedule required to meet the needs of the camp, the Quartermaster directed, in Hill's words, that "construction work on the Salinas River Project proceed simultaneously with the preparation of plans and specification."[16] This directive represented an almost unprecedented decision in modern water resource development, to begin construction of the dam while plans were still at the preliminary phase.

Legal rights to store water were secured immediately. In May, 1941, the City of San Luis Obispo and officials of Camp San Luis Obispo reached agreement on a joint effort to develop Salinas River water for the mutual benefit of the two parties.[17] The water storage project would involve three major components: a new dam on the Salinas River; a tunnel to divert water through the Santa Lucia Range; and miscellaneous water delivery lines to carry the water from the dam to the tunnel and from the tunnel to Camp San Luis Obispo and the city. The Army and the city jointly filed for water

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[14] Born "Salinas Dam -- A Remarkable Engineering Achievement," 1993, 4.
[15] Leeds, Hill, Barnard, and Jewett, "Report to United States Engineer Office," 1942, 3.
[16] Leeds, Hill, Barnard, and Jewett, "Report to United States Engineer Office," 1942, 3.
[17] San Luis Obispo *Telegraph-Tribune* (May 13, 1941), 1.

rights in May, 1941.[18] Total project cost was estimated at $2.4 million, the City of San Luis Obispo responsible for about $1/2 million.

Having secured the water rights, the Quartermaster Corps authorized immediate construction work to begin on the abutments for the dam. As Hill noted, it was highly unusual (and somewhat risky) to initiate excavations for the abutment of the dam, given the fact that the engineer had only cursory knowledge of the site:

> For this reason preliminary designs of all of the several construction features of the dam and aqueduct project had to be based upon observable surface features of the topography without the opportunity for extended exploration of the soil, rock, and foundation conditions for which time is usually made available under ordinary circumstances.[19]

The construction and design contracts were both signed in May, 1941. From that date forward, construction and design work proceeded simultaneously. This inevitably resulted in changes in project design over the course of the project, some minor and some major. The April, 1941 report from Hill recommended a dam with the crest at elevation 1305'; in July, 1941, the Quartermaster Corps directed that the dam would crest at elevation 1319' to achieve a storage capacity of 45,000 acre-feet. Excavation was already underway on the abutments at this time. The design team determined that the 1319' height was incompatible with work already completed to that point. To achieve the desired capacity, Hill devised a scheme by which the dam would include a spillway crest at elevation 1301 but, through installation of an automatic drum gate in the spillway, the reservoir itself could be allowed to rise to elevation 1319. The Corps of Engineers later determined that the bedrock foundation might be unsafe and that the larger capacity was not needed, therefore, the drum gate was never installed. The drum gate was transferred to the Corps of Engineers' Friant Dam division and was installed in that structure.[20]

Between June, 1941 and January, 1942, design and construction work proceeded at an almost unprecedented pace. Excavation was initiated at the dam site on June 24, 1941. The first concrete was poured on September 5, 1941. The dam was closed on December 6, 1941 and nearly the entire inflow to the reservoir was stored, even though major design decisions were yet to be made and major construction work still underway.[21] **(Photograph CA-183-21)** For practical purposes, then, the dam was made operational during the course of less than six months.

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[18] San Luis Obispo *Telegraph-Tribune* (May 14, 1941), 1.

[19] Leeds, Hill, Barnard, and Jewett, "Report to United States Engineer Office," 1942, 4.

[20] Born "Salinas Dam -- A Remarkable Engineering Achievement," 1993, 26.

[21] D.P. Lane, Major, Corps of Engineers, "Completion Report, Salinas River Project Near Santa Margarita, California, Sub-Post of Camp San Luis Obispo, California." Fixed Fee Contract Job No. T-41-5," May 9, 1942. National Archives, RG 77, Construction Completion Reports, 1917-1943, Salinas River Project, Box 274.

During that period, major design changes were made to deal with discovered conditions, most having to do with the geology of the dam site. The dam was initially designed as a constant-angle, variable-radius concrete arch. That design element never changed. During excavations for the abutments, however, it was discovered that the rock in both abutments was considerably more fractured than had been supposed on the basis of surface reconnaissance. The fractured rock necessitated greater excavation and the drilling of many more grout holes than had been planned. Revised plans were submitted to the Quartermaster Corps on a monthly basis, in June, July, and August, 1941.[22] The plans for the abutments changed radically to account for the poorer-than-expected geological conditions. The principal revision involved construction of concrete footings much larger than originally planned, below the arch ring and the buttresses. Upon taking control of the dam, the Corps of Engineers observed that the arch for the dam was not actually cast into the stone at the abutments but rather "rests upon a concrete footing which extends up the canyon walls to about two-thirds the height of the dam."[23] Another late design modification was the construction of concrete struts in the riverbed below the right (west) abutment of the dam. The right (west) abutment was founded in sandstone ledges with siliceous shale between the ledges. The seams between the ledges were not exposed until construction had begun because little exploratory testing had been conducted before construction. Because of the relatively unstable nature of the sandstone and shale the concrete struts were added as foundation supports. The struts, poured to align with the thrust of the right (west) buttress, were designed to support not only the buttresses, but also the sandstone ledges upon which they sat.[24] **(Photograph CA-183-22)**

The spillway for the structure is a curved concrete chute placed at the right side of the dam, with a distinctive spiral, or "superelevation" along the chute. This type of spillway had been developed by Raymond A. Hill almost a decade earlier for use on the Bartlett Dam, which was built by the U.S. Bureau of Reclamation on the Salt River Project.[25] The spiral spillway was selected because conditions at the site would have required very extensive excavations to maintain a traditional straight spillway.[26] **(Photograph CA-183-23)**

While the primary focus of the construction effort was on the Salinas Dam, the job of Leeds, Hill, Barnard and Jewett and L.E. Dixon Company was far more complex. The two companies were simultaneously designing and constructing the dam, and also attempting to complete construction of the basic cantonment at Camp San Luis Obispo, a kind of instant city of 20,000 men. Work was also underway to build the related facilities for the Salinas River Project, including a 15-mile

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[22] Lane, "Completion Report, Salinas River Project," 1942, 5.

[23] Lane, "Completion Report, Salinas River Project," 1942, 5.

[24] Leeds, Hill, Barnard, and Jewett, "Report to United States Engineer Office," 1942, 10-1 to 10-3.

[25] Raymond A. Hill and D. C. McConaughy, "Design of Spillway Chutes," *Civil Engineering*, (November, 1945), 455. Although the article was published in 1945, the distinctive "spiral spillway" was first used in 1934, credited to Raymond A. Hill's design, developed under contract with the Bureau of Reclamation.

[26] Leeds, Hill, Barnard, and Jewett, "Report to the United States Engineer," 1942, 12-1 to 12-7.

conduit, various filtration reservoirs on the base, and pipelines for water deliveries to the many buildings on the base and to the City of San Luis Obispo. The most challenging aspect of the project, other than the dam, was the Cuesta Tunnel, a mile-long bore through the Cuesta Grade. The tunnel was designed and built in less than nine months, an engineering and construction feat that rivals construction of the dam in terms of its daring and remarkable speed. The Cuesta Tunnel has been determined eligible for listing in the National Register of Historic Places, chiefly on the basis of the heroic aspects of its construction.[27] These appurtenant works are germane to the construction history of the Salinas Dam in that they were being designed and built at the same time, involving the same A&E and construction contractors.

The dam was closed (i.e., the arch was completed) in late 1941, which accomplished the primary objective of storage of wintertime flows during 1941-42. A great deal of construction, however, remained to be completed on the dam and the delivery system. The tunnel was not completed until March of 1942.[28] **(Photograph CA-183-24)** The reservoirs in Camp San Luis Obispo and the aqueducts between the dam and the camp were completed even later.

On January 1, 1942 command over cantonment construction (including the dam, in this case), passed from the Quartermaster Corps to the Army Corps of Engineers. Upon taking control of the project, the Corps of Engineers realized that the project had proceeded in a somewhat unusual manner, driven by the intense desire of all parties to get the dam built in time to store wintertime flows. The Corps of Engineers inquired of the A&E firms (which, it will be recalled, included two officers and a former District Engineer among its partners) as to the types of reports that had been filed, prior to initiating construction. Hill acknowledged that the bulk of the work had proceeded with minimal documentation. During the course of filing a 20-volume report on the project, submitted to the Corps of Engineers in April, 1942, Hill observed that:

> While the report of April 7, 1941 [the initial report prepared by Hill] sets forth the purpose and general scope of the Salinas River Project, and while the Completion Report on the Project will describe all construction features and will include drawings showing the various units of the work as built, no report on the design of these works has previously been made

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[27] The Cuesta Tunnel was determined eligible on the basis of documentation prepared by the California Department of Water Resources. Glenn Farris, "The Cuesta Tunnel, San Luis Obispo County, California" (California Department of Water Resources, May 5, 1993.) The tunnel was subsequently recorded to the standards of the Historic American Engineering Record, prior to its modification by the California Department of Water Resources as part of the agency's Coastal Branch of State Water Project. That recordation carries HAER No. CA-153-A, recorded by Stephen D. Mikesell and David DeVries, "Historic American Engineering Record, Salinas River Project, Cuesta Tunnel, HAER No. CA-153-A," July 1994.

[28] Mikesell and DeVries, "HAER, Salinas River Project, Cuesta Tunnel," 7.

> because of no request or authorization by the Office of the Quartermaster General.
>
> This deficiency was noted by the United States Engineers Office soon after jurisdiction over the project was transferred from the former to the latter, and on January 29, 1942, the District Engineer requested of us a copy of the Analysis of the design of Salinas Dam. Subsequently, after an exchange of correspondence, a complete outline of the desired report was furnished to us by the District Engineer in his letter dated January 18, 1942. Copies of these letters follow. This report on Analysis of Design of Salinas River Project is therefore supplemental to all pertinent reports, plans, and specifications which have been prepared and submitted by a member of this firm as an individual and by the firm as Architect-Engineer.[29]

The Corps of Engineers filed a Completion Report for the project in May, 1942, shortly after Hill had filed his report on the design of the facility. The fact that the design analysis report and completion report were filed within a month of one another is probably a unique occurrence among Corps of Engineers projects and likely among dam projects in the United States generally, a fact that can be explained only through an analysis of the events, as described. The May 1942 Corps of Engineers report described the structure the agency accepted when it took over the project and closed out the contract with Leeds, Hill, Barnard, and Jewett.[30]

During the remaining months of 1942, while the reservoir was filling and the water system was being used, the Corps of Engineers, Los Angeles District, conducted the basic analyses -- seismic analysis, safe yield analysis, geologic analysis, and so forth -- that are ordinarily conducted before, rather than after, a dam has been completed.

The analysis by the Corps of Engineers determined that the structure was essentially sound, a conclusion that has since been confirmed by the performance of the dam for more than half a century. Nonetheless, the Corps did express some concern about the unusual manner in which the dam was built and some of the unique characteristics of the structure. "The dam is of unusual design," the Corps observed in a 1943 report, "and was constructed with great speed in order to impound the flood run-off during the winter of 1941-42."[31]

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[29] Leeds, Hill, Barnard, and Jewett, "Report to the United States Engineer," 1942, 1-4 to 1-5. Hill's reference to "a member of this firm as an individual" relates to his dual role as a principal in Leeds, Hill, Barnard, and Jewett and the fact that he was hired separately to serve as dam design expert for the Quartermaster Corps.

[30] Lane, "Completion Report, Salinas River Project," 1942.

[31] United States Engineer Office, Los Angeles, California. "Report on Salinas Dam, Salinas River, California," (June 15, 1943), vi. Corps of Engineers analysis was very extensive, focusing chiefly on the

Corps of Engineers until the final abandonment of Camp San Luis Obispo by the Army in about 1956. Since then, the water system has been leased by the Corps of Engineers to the Flood Control District of the County of San Luis Obispo, which operates the system chiefly to supply drinking water to the City of San Luis Obispo.

From the time of its construction until the present day there have been no major changes to the Salinas Dam. A series of minor modifications, however, have been made to the dam, since the late 1960s: At some time after 1969 the area below the spillway was covered with gunite to protect the rock face from erosion; in the mid-1970s the release valves on the left hand side of the dam were replaced; the valves on the right hand side were replaced in 1996; at the same time as the release valves were replaced the intake structures were also modified to allow water to be drawn from various levels of the lake.

Technological and Military History

The Salinas Dam represents a significant property in two contexts: military history and engineering. The dam stands as a monument to the "can do" attitude of the Army and its contractors during this period, the attitude that, because great challenges were facing the nation, essentially any obstacle could be overcome given sufficient will and resources. Whether considered within the context of military construction or dam construction in California, the Salinas Dam appears to be a significant property. It retains a high degree of integrity of design, materials, workmanship, feeling, association, location, and setting. The property being evaluated is the dam itself, abutment to abutment and upstream face to downstream face, as well as the pumping plant downstream; this evaluation does not assess the aqueduct or any other element of the water delivery system called the Salinas River Project, other than the Salinas Dam.

The historical significance of the dam has already been recognized by the California Council of the American Society of Civil Engineers Sections, which designated the property as a Historic Civil Engineering Landmark in California in 1996.[35] The basis for the ASCE designation was substantially the same as presented herein, relating to the haste with which the structure was designed and built and its durability, despite that attenuated construction schedule.

As noted, the importance of the Salinas Dam may be appropriately considered under two contexts: military construction in California just before and during World War II (1940-45); and dam construction in California during the first half of the 20th century. The significance of the structure within each context is discussed separately below, although the two are very closely related.

A small but growing body of literature analyzes the property types and the potential architectural significance of buildings and structures that were built by the American military stateside (as

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[35] Telephone conversation with Robert H. Born, P.E., August 12, 1996.

The Corps conducted a wide range of studies and discovered only one worrisome condition. The right (west) buttress was found to be under-designed to handle stresses associated with a water level of 1319, the level achieved only through use of the automatic gate. The Corps analyst observed: "The results show that under the most adverse conditions of loading, water surface at elevation 1319 and earthquake accelerating up canyon, the stresses in the right buttress are higher than desirable. With the permanent operating level established at elevation 1301 (surcharge 11 feet), the factor of safety increases to a level consistent with good engineering practices."[32]

For this reason, the Corps of Engineers declined to install the automatic gate; the gate was shipped to the Friant Dam on the San Joaquin River near Fresno, then under construction by the Corps of Engineers. The Salinas Dam gate and gate control chamber were filled with concrete. In addition, the Corps of Engineers ordered miscellaneous grouting of foundation rock and in some parts of the struts and buttresses at the abutments.[33]

The Salinas River Project -- dam, tunnel, and delivery system -- performed well during World War II, delivering minimal water supplies to Camp San Luis Obispo and supplemental water to the City of San Luis Obispo. Camp San Luis Obispo continued to serve as a regular Army base only through the end of the war. The property was returned to the California National Guard in 1947.[34] The Federal government leased the property again in 1951, at the beginning of the Korean conflict, and maintained control of the facility through 1965. At that time, the property was returned to the California National Guard. The camp has continued to serve as a National Guard training facility since that date, although its relative importance was diminished when the state acquired Camp Roberts, another World War II-era Army training camp which is now used as the principal National Guard facility. Camp Roberts straddles the Monterey-San Luis Obispo county line, between San Luis Obispo and Salinas. Since 1965, about 1000 acres of the original Camp San Luis Obispo have been transferred from the Guard to other agencies or private individuals. Some parts of Camp San Luis Obispo are now used by other agencies of the State of California, including the departments of Transportation and Corrections.

The control and ownership of the water system -- the Salinas Dam and reservoir, as well as the aqueduct -- was retained by the Corps of Engineers after the war. It was operated directly by the

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seismic stability of the structure. The Corps of Engineers brought in several experts from the University of California as well as in-house dam safety experts from throughout the United States. The results of these studies are summarized in Chester Marliave, "Geological Report on Safety of Upper Salinas Dam in California," (September 12, 1942.) The early geological studies of the dam are summarized in Woodward-Clyde Consultants, "Task Memorandum, Task 1 - Geotechnical Evaluation for Salinas Reservoir Expansion Project," (4 November 1988.)

[32] United States Engineer Office, "Report on Salinas Dam," 1943, ix.

[33] United States Engineer Office, "Report on Salinas Dam," 1943, x.

[34] The post-World War II history of the camp is summarized in the California Military Department, "Quadrennial Report, 1987-1990" (Sacramento, 1990), 114.

opposed to war theater construction) during World War II.[36] The principal focus of this literature is on typical cantonment building types, such as barracks, administrative buildings, assembly halls, and so forth, particularly buildings constructed to "temporary" specifications. Temporary buildings were simply buildings constructed at the least cost yet capable of meeting minimal health and safety standards. These temporary buildings were also often built from standardized plans, developed by the Corps of Engineers for use on Army and Air Corps (Air Force) bases and by the Bureau of Yards and Docks for Navy and Marine bases.

The use of standardized plans and rather flimsy design standards enabled contractors to build up these bases with remarkable speed. The engineering and building trade journals of the period are filled with stories of the stunning speed with which these bases were constructed. Charles T. Leeds of Leeds, Hill, Barnard, and Jewett produced one such article, apparently dealing with Camp San Luis Obispo, which appeared in the October and November, 1942 issues of *Civil Engineering*.[37] Other articles appearing in the engineering and building trade journals also emphasized this remarkable speed of construction. The awe of the authors is apparent in the article titles: "A Building Every 54 Min. at Ford Ord"; "A Thousands Buildings in Five Months"; "Erect Company Barracks in Three Hours"; and so forth.[38]

The same fast-paced construction schedule was followed in overseas bases, particularly in the Advance Base work of the Construction Battalions, or "Seabees" of the U.S. Navy.[39] The Seabees adopted the phrase, "can do," to characterize their approach to the seemingly impossible construction schedule and working conditions imposed by the war. The phrase applies equally well, however, to the frantic pace of the private construction firms charged with building the stateside bases and to the private A&E firms that designed those bases.

In one sense, the Salinas Dam stands as a typical example of this "can do" approach to construction during the war. The dam was designed and built with the same haste with which the associated Camp San Luis Obispo was constructed, and was the work of the same design and construction firms. The dam was designed and the gates closed over the course of about six months, ranking it among the most hastily-erected major dams to be found anywhere in California or the United States. Measured simply in terms of speed of construction, the Salinas Dam is a major achievement and one

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[36] As noted, Garner, 1993, represents the best single-volume treatment of this period and type of construction. Separate, more focused studies look at Navy construction and the development of individual building types from the era, such as the Quonset hut.

[37] Leeds, "A West Coast Cantonment." Part 1, 541-544; Part 2, 611-612.

[38] These titles appear in the bibliography of Garner, 1993, all from *Engineering News-Record* in 1942 and 1943. Similar types of articles were common in wartime issues of construction-oriented journals, such as the *Southwest Builder and Contractor*, a Los Angeles-based publication.

[39] William Bradford Huie, *Can Do! The Story of the Seabees* (New York: E.P. Hutton & Co., Inc., 1944.)

that can be best appreciated within the general context of rapid cantonment construction during the early years of World War II.

In another sense, however, the Salinas Dam is highly unusual within the context of cantonment design and construction because it represents a much more substantial and complex structure than the typical buildings at such bases, and a much more complex infrastructure element when compared against the road systems, sewers, and other typical elements of military base infrastructure.

Throughout the history of American civil engineering, dam design has always represented a special place among the achievements of the profession, on a par with very large bridges in terms of the inherent difficulties in design and the major public safety concerns posed by such structures. The context for evaluating the historic significance of these two major civil engineering features -- dams and bridges -- is presented in Donald Jackson's recent study, *Great American Bridges and Dams.*[40] The history of dam engineering is treated in numerous publications, including the very useful 1988 book, *Development of Dam Engineering in the United States.*[41]

The Salinas Dam, as designed by Raymond A. Hill, represents a particular generation in concrete arch dam design. As described in the aforementioned *Development of Dam Engineering in the United States,* the constant-angle, variable-radius dam was an innovation conceived and first executed by engineer, Las Jorgensen, with the first such dam being built in Alaska in 1913. Jorgensen's analysis of the design postulated two advantages over traditional constant-radius dam: "There are two features which distinguish this type of dam from the ordinary arch dam. These are (1) economy of material, and (2) ability of the dam to act as an arch, even close to the foundation, to a much greater extent than the ordinary arch dam."[42]

Dozens of such dams were built, chiefly in the Western United States, from the late 1910s through the 1930s. Several of these were Reclamation Service (Bureau of Reclamation) dams, including the Gerber Dam, built in Oregon as part of the large Klamath Project. Raymond Hill had worked directly for the Reclamation Service until World War I and consulted with the agency for many decades later. He, no doubt, was familiar with the agency's use of this dam form and may have participated in the design of some of these structures.

The Salinas Dam does not appear to represent a significant example of the dam form in terms of its size or as a pioneering work. It certainly was not an early example: as noted, the initial example dates to 1913 and the bulk of the examples of the type appear to date to the 1920s. Neither is it a

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[40] Donald C. Jackson, *Great American Bridges and Dams* (Washington, D.C.: The Preservation Press, 1988.)

[41] Eric B. Kollgaard and Wallace L. Chadwick, editors, *Development of Dam Engineering in the United States* (Washington, D.C.: The United States Committee of the International Commission on Large Dams, 1988.)

[42] Kollgaard and Chadwick, *Development of Dam Engineering in the United States*, 245.

particularly large example. The Spaulding Dam of the Pacific Gas and Electric Company on the Yuba River in California is one of the largest concrete dams in the world (it is 276' high) and is classified as a constant-angle dam by the International Commission on Large Dams. It was also a very early example of the type, having been completed in 1919.

The dam, however, does appear to represent an important innovation in the general design of the dam type. The particular form of the Salinas Dam -- an inclined variable-radius arch with integral buttresses -- appears to have been an invention of Leeds, Hill, Barnard, and Jewett. Evidence to support this is very sketchy, restricted to Hill's description of the dam in his 1942 report to the Corps of Engineers. Hill wrote:

> The shape of the dam site suggested the use of a Hoof type dam as previously developed by this office. In principle, such a dam consists of an inclined arch barrel, supported by buttresses, forming an externally and internally stable, self-contained unit... An independent arch footing was added in this case to provide ready adjustment of the structure to foundation conditions without appreciable effect on the theoretical arch. This was necessary in view of the absence of adequate exploration prior to the final design.[43]

The 1942 Completion Report prepared by the Corps of Engineers also refers to the dam as a "Hoof" type. No reference was found in general literature on dam design to substantiate that the "Hoof" design was an invention of the Leeds, Hill, Barnard, and Jewett, although that is the clear implication of Mr. Hill's remarks.

The distinctive qualities of the Salinas Dam relate chiefly to the use of concrete footing and concrete buttresses at the abutments. While the buttresses were a characteristic element of the "Hoof" design, the footings were a unique adaptation to conditions at the dam site, including the fact that the dam was to be constructed with little knowledge of the conditions of the proposed abutments; the footings compensated for known and anticipated problems with the abutments. To a lesser degree, the dam is distinctive for the use of a spiral spillway, which was also invented by Raymond A. Hill. These characteristics make the Salinas Dam a highly unusual, if not a unique, structure. To some extent, the distinctive elements were the result of prior work by the firm in developing dam forms and elements. To a larger extent, the dam form was Mr. Hill's response to unusual conditions at the dam site which were only discovered during the course of the final design and construction and the even more unusual conditions under which the dam was designed and built.

Within the context of dam engineering, the Salinas Dam appears to be significant chiefly for the manner in which it was designed and built. Raymond Hill was asked to prepare plans and specifications while the dam was actually under construction and without the benefit of detailed analyses of the site. Hill does not record why he selected the "Hoof" dam form, except to note that

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[43] Leeds, Hill, Barnard, and Jewett, "Report to the United States Engineer," 1942, 5-1.

it was appropriate to the "shape of the dam site." He does record, however, the rationale for the concrete footings, which were added to adapt the dam to its site and to compensate for the absence of exploratory drilling prior to design and construction. The dam, then, was simply a solution to a particular problem, customized to fit the circumstances. The fact that it was produced under an extraordinary schedule and almost unprecedented circumstances speaks to the achievement of the engineer and the contractors. Although hastily built, the dam remains a viable structure and has suffered very little deterioration in a half-century of use.[44]

In the end, the significance of the dam is much the same whether seen in the context of cantonment construction in the World War II-era or in the larger context of the history of dam engineering. The nomination papers for designating it as an ASCE Landmark in Civil Engineering call the dam "a remarkable engineering achievement," pointing to the "unprecedented timing and construction of Salinas Dam, together with its actual performance over the past 52 years."[45] These two qualities -- great haste of construction and success of the design -- capture the essence of the significance of the dam.

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[44] The dam has been re-studied extensively in recent years in preparation for proposed modifications to increase the water supply. These studies are summarized in Born, "Salinas Dam -- A Remarkable Engineering Achievement," 1993.

[45] Born, "Salinas Dam -- A Remarkable Engineering Achievement," 1993, 30.

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IV. PROJECT DESCRIPTION

The City of San Luis Obispo proposes to implement the Salinas Reservoir Expansion Project, the purpose of which is to expand the capacity of the Salinas Reservoir by installing an operable gate in the spillway of the existing dam. Salinas Reservoir is the city's primary water supply. The project would complete the dam as originally designed and raise the reservoir height by approximately 19 feet. The project would expand the maximum storage capacity from 23,843 acre-feet (AF) to 41,792 AF, an approximately 75 percent increase in capacity. The project would increase the reservoir surface by about 400 acres from 730 to 1130 acres. The city's safe annual yield from the reservoir would increase by 1.650 acre-feet per year (AFY).

The Army Corps of Engineers owns the dam, reservoir, and the majority of the surrounding land (4400 acres). The San Luis Obispo County Flood Control and Water Conservation District operates the dam for the city and the county operates the recreational area, Santa Margarita Lake Regional Park, which includes the Corps of Engineers lands as well as lands owned by the county. The Corps of Engineers has indicated that the property must be transferred from federal to local control prior to implementation of the proposed Salinas Reservoir Expansion Project.

The project includes the following components or activities:

1. Modification of the existing dam spillway to expand the reservoir capacity, strengthening of the dam base to protect against erosion related to operation of the modified dam, and possibly grouting of the bedrock foundation of the dam to seal cracks in the bedrock that might otherwise leak once the water level in the reservoir was raised.

2. Relocation of recreational facilities and associated access road segments that would be subject to inundation.

3. Maintenance of north shore access road segments that would be subject to periodic inundation.